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A. Mitsiukhin / A. Karcheuski

Filtration of Videographic Data by Means of Hartley Discrete Transform

QUALITY MEASUREMENT AND INDUSTRIAL IMAGE PROCESSING

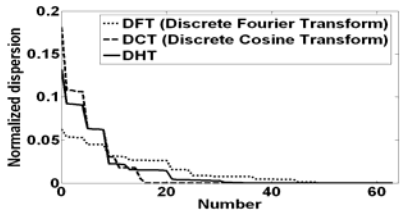
The aerospace multiregion probing is used for the purpose of ecological monitoring, detection of ignition of peatbog deposits and woodlands, accounting the land soli resources, etc. Reducing the volumes of the video graphic information is critical for improving the efficiency of the monitoring. The purpose of this paper consists in demonstrating the method of spectral correlation image processing reducing the excessiveness when selecting the spectral signs, detection and localization of the image objects. The dispersion filtration of the spectral characteristics of the object being observed by means of the algorithm for computing the Hartley discrete two-dimensional orthogonal transform (DHT) is considered. The discrete DHT kernel is expressed through the Hartley functions having the form

$$cas\left(\frac{2\pi kn}{N}\right)=\cos\left(\frac{2\pi kn}{N}\right)+\sin\left(\frac{2\pi kn}{N}\right), k,n\subset\{0,1,...,N-1\}.$$

The dispersion filtration is featured by the fact that the dispersions of the transformation factors (transformants) for the field of constant-brightness pixels tend to zero values. The transformants with non-zero values make it possible to select the object. The filtration is implemented through computing the distribution function of the 2-D dispersion of the transformants: $diag[\tilde{\sigma}^2]=diag\left[\tilde{K}_C\right]\otimes diag\left[\tilde{K}_R\right]$, where $diag\left[\tilde{K}_C\right]$ and $diag\left[\tilde{K}_R\right]$ are diagonal covariance matrices of the columns and rows of the DHT transformant matrix. The visually uniform objects, on which background there was a set of pixels with similar brightness values, were considered as an image.

Assessment of the processing efficiency. Let g, G and $\hat{g}=\begin{bmatrix}123 & 123\\ 121 & 119\end{bmatrix}$ have the following meaning: g is the discrete image, G is the DHT transformant matrix of the fragment g, $\hat{g}$ is the object under observation. The graphs of the functions of distribution of the 2-D dispersions $\tilde{\sigma}^2$ DHT, DFT and DCT of the image g demonstrate the filtration efficiency.

$$g=\begin{bmatrix} 20 & 19 & 19 & 19 & 19 & 18 & 18 & 18 \\ 19 & 18 & 19 & 18 & 17 & 18 & 17 & 17 \\ 19 & 18 & 18 & 17 & 17 & 17 & 16 & 17 \\ 18 & 17 & 17 & \mathbf{123} & \mathbf{123} & 17 & 16 & 16 \\ 18 & 17 & 17 & \mathbf{121} & \mathbf{119} & 16 & 15 & 15 \\ 17 & 16 & 16 & 16 & 16 & 16 & 15 & 14 \\ 17 & 16 & 15 & 15 & 15 & 15 & 14 & 14 \\ 16 & 15 & 15 & 15 & 14 & 14 & 14 & 13 \end{bmatrix}, \quad G=\begin{bmatrix} 1480.0 & -177.9 & 22.0 & 104.1 & 10.0 & -192.1 & 424.0 & -518.13 \\ -145.9 & 104.8 & -6.2 & -49.9 & 0.6 & 104.8 & -207.4 & 253.9 \\ 34.0 & 1.5 & -4.0 & 1.0 & 0 & 4.41 & -6.0 & 1.0 \\ 120.6 & -53.3 & 3.4 & 15.6 & 0.6 & -49.3 & 95.2 & -110.2 \\ 16.0 & 9.2 & 2.0 & -2.7 & -2.0 & 0.8 & 0 & 8.7 \\ -194.0 & 99.1 & 2.2 & -45.9 & 3.4 & 99.2 & -204.6 & 249.9 \\ 422.0 & -209.5 & -4.0 & 90.8 & 0 & -212.4 & 422.0 & -508.8 \\ -532.68 & 253.3 & 0.6 & -101.8 & 3.4 & 249.32 & -507.2 & 612.4 \end{bmatrix},$$



Figures 1, 2, 3 show the graphs of the Hartley spectrum G of the fragment g of the filtered spectrum $\tilde{G}$ and the Hartley spectrum $\tilde{\tilde{G}}$ after the lexico-graphical arrangement of the transformants $\tilde{G}$; (compression ratio K=4).

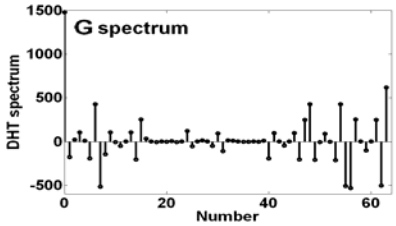


Figure 1

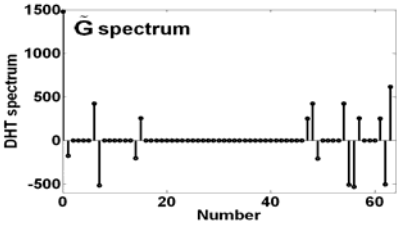


Figure 2

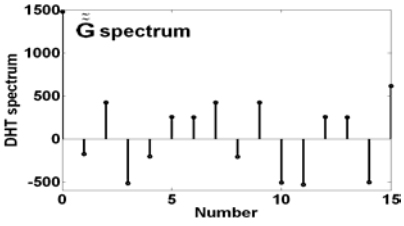


Figure 3

After quadruple compression, the count matrix $\hat{g}$ has the following form: $\hat{g}=\begin{bmatrix} 108 & 110 \\ 113 & 110 \end{bmatrix}$.

Fig. 4 illustrates the filtration quality by means of DHT и DCT.

The detection of the specified object $\hat{g}$ and space localization of the two images were performed by computing the 2-D correlation function in the DHT frequency band. Figures 5 and 6 present the image of the 2-D correlation function and the point, by which the $\hat{g}$ coordinates are determined.

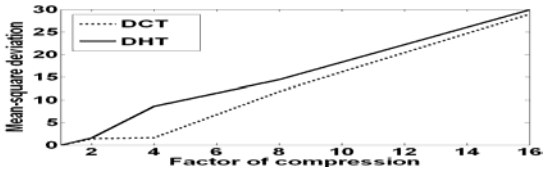


Figure 4

Figure 5

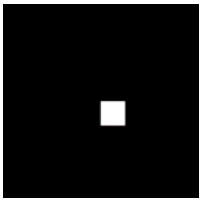


Figure 6

Conclusions. At the stage of pre-processing of videographic information, the DHT is applicable for description of spectral peculiarities of the object to be revealed, e.g. for the identification purpose. When solving the image detection and localization problems, the DHT would make it possible to reduce the volume of computations.

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[1] Theory of Applied Encoding: Tutorial In 2 volumes/V.K. Konopelko, A.I. Mitsiukhin, et al.; Edited by Prof. V.K. Konopelko. – Minsk: Belarussian State University of Informatics & Radioelectronics, 2004. – 398 pages: illustrations.

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